(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) Publication number: 0 310 372 A2

(12) # EUROPEAN PATENT APPLICATION

(21) Application number: 88309021.9

(22) Date of filing: 29.09.88

(51) Int. Cl.4: A 61 K 6/02

(30) Priority: 30.09.87 JP 248631/87
14.01.88 JP 6603/88

(43) Date of publication of application:
05.04.89 Bulletin 89/14

(84) Designated Contracting States: DE FR GB IT NL

(71) Applicant: KURARAY CO., LTD.
1621 Sakazu
Kurashiki-City Okayama Prefecture 710 (JP)

(72) Inventor: Hosoda, Hiroyasu
2-36-3, Hakusan
Bunkyoku Tokyo (JP)

(74) Representative: Thomas, Roger Tamlyn et al
D. Young & Co. 10 Staple Inn
London WC1V 7RD (GB)

(54) **Dental composition.**

(57) A dental composition for the treatment of the enamel and/or dentin of a tooth comprising an organic carboxylic acid or an anhydride thereof, a metal chloride and water, the concentration of said organic carboxylic acid or anhydride thereof being 5 to 50 weight percent based on the total weight of said composition, said metal chloride being potassium chloride or calcium chloride or a mixture thereof and the concentration of said metal chloride being 5 to 50 weight percent based on the total weight of said composition. The composition assures an improved bond between the tooth and a filling material such as a composite resin, a pit and fissure sealant, a cementing agent or the like which is used for example in the treatment of caries.

EP 0 310 372 A2

Description

DENTAL COMPOSITION

This invention relates to a dental treatment with a dental composition for improving the bond between a tooth and a dental filling material. The invention also relates to a dental composition for assuring an improved bond between a tooth and a filling material such as a composite resin, a pit and fissure sealant, a cementing agent or the like, which is used for example in the treatment of caries.

In the treatment of dental caries, it is common practice to pretreat the enamel of the affected tooth with an aqueous acid solution to assure a firm bond between the tooth and an organic material (e.g. a composite resin, a glass ionomer cement, a carboxylate cement, a composite resin cement or a pit and fissure sealant). As such an enamel treatment agent, an aqueous solution of phosphoric acid or citric acid has heretofore been employed widely and from the standpoint of effectiveness, an aqueous solution containing 20 to 60 percent by weight of phosphoric acid has been recommended.

In particular, a composite resin used in the restorative filling of a carious tooth portion, which consists of a synthetic resin and an inorganic filler, has only poor adhesion to the tooth and much research has been undertaken for improving its adhesion. An effective restorative procedure heretofore known for dental caries comprises removing the carious part of the tooth, etching the enamel wall of the resulting cavity with an aqueous acid solution (e.g. an aqueous solution of phosphoric acid), then applying an adhesive containing a polymerisable monomer which is a component of a composite resin and finally filling the cavity with the composite resin. However, since the tooth comprises enamel and dentin and the cavity formed by removal of a carious portion has the exposed walls of both the enamel and the dentin, it is desirable that the composite resin is bonded firmly to both the enamel and the dentin. For this reason, recent practice involves the use of adhesives containing a special polymerisable monomer having an affinity for dentin.

When the carious tooth is cut with a dental burr, a smeared layer is formed on the cut surface. It is believed that this smeared layer includes the bacteria derived from the caries and those resident in the oral cavity. Furthermore, if a restorative procedure with a composite resin is performed with the smeared layer as it is, the composite resin will separate from the smeared layer because the smeared layer is brittle.

Moreover, the irritating effect which the bacteria included in the smeared layer exerts on the dental pulp may also be a serious concern. Therefore, the smeared layer is preferably removed before the restorative procedure using a composite resin is actually undertaken. If the whole surface of the burred cavity is treated with an aqueous solution of phosphoric acid, the smeared layer on the enamel and dentin will be completely removed but the dentinal tubules plugged by the smeared layer will then be exposed and irritant substances may easily reach the pulp through the tubules to cause untoward effects. Therefore, attempts were made to use various organic carboxylic acids, in lieu of phosphoric acid, for the pretreatment of the dentin. It has been reported that the use of an aqueous solution of citric acid, oxalic acid or formic acid and/or a metal salt such as ferric oxalate, ferric chloride or the like was effective for the aforementioned purpose (e.g. Nakabayashi et al, Journal of the Japan Society for Dental Apparatus and Materials, 23, 61, 29-33, 1982). However, even when the enamel is pretreated with such a known agent, the bond between the composite resin and the enamel is not as good as that attainable by using an aqueous solution of phosphoric acid. Therefore, it is generally necessary to first pretreat the dentin with an organic carboxylic acid or the like and then pretreat the enamel with an aqueous solution of phosphoric acid, thus adding to the complexity of the restorative procedure.

Thus, while the dental treating agents containing organic carboxyic acids are effective for the dentin, they are not so effective for the enamel and, therefore, the enamel must be subsequently treated with an aqueous solution of phosphoric acid, thus adding to the complexity of the clinical procedure as mentioned above. Thus, organic carboxylic acids are not universally suited for the treatment of all classes of dental caries.

Although the most important function which a dental treating agent is expected to perform is an enhancement of the bond strength between the filling material and the enamel and dentin, it is also important that such an agent have a limited denaturation effect on the dentin, particularly on its collagen.

Paying due attention to the above requirements, the present inventor tried to develop a dental composition which, in lieu of phosphoric acid, would simultaneously treat both the enamel and dentin for successful restoration.

The research was directed to the employment of an organic carboxylic acid, which is acknowledged to be effective for the dentin without adverse effects on the pulp, in combination with an additive agent which will potentiate the adhesion enhancement of the organic carboxylic acid on the enamel and the exploration of the optimum concentration of the additive agent. This invention has been accomplished on the basis of the above research.

The dental composition provided by this invention comprises, as essential components, an organic carboxylic acid, a metal chloride, and water.

The organic carboxylic acids useful for this invention include monocarboxylic acids, dicarboxylic acids, tricarboxylic cacids, tetracarboxylic acids and anhydrides thereof. As exemplary species of such monocarboxylic acids and anhydrides thereof, there may be mentioned formic acid, acetic acid, lactic acid, butyric acid, valeric acid, nonanoic acid, hexanoic acid, heptanoic acid, lauric acid, pyruvic acid, glycine, methacrylic acid, acrylic acid, crotonic acid, benzoic acid, aminobenzoic acid, salicylic acid, aminosalicylic acid, acetic anhydride, butyric anhydride, valeric anhydride, lauric anhydride, glycine anhydride, crotonic

anhydride and the like. As exemplary species of said dicarboxylic acids and anhydrides thereof, there may be mentioned oxalic acid, succinic acid, tartaric acid, glutaric acid, fumaric acid, maleic acid, malonic acid, citraconic acid, itaconic acid, (o-,m-,p-)phthalic acid, (α-, β-) naphthalic acid, 2,3-naphthalenedicarboxylic acid, 2-methacryloyloxyethyl trimellitate, succinic anhydride, maleic anhydride, citraconic anhydride, itaconic anhydride, phthalic anhydride, naphthalic anhydride, 1,8-naphthalenedicarboxylic anhydride, 2-methacryloyloxyethyl trimellitic anhydride and the like. Said tricarboxylic acids and anhydrides thereof include citric acid, trimellitic acid, trimesic acid and trimellitic anhydride. Said tetracarboxylic acids and anhydrides thereof include ethylenediaminetetracetic acid (EDTA), salts thereof, pyromellitic acid and pyromellitic anhydride. Poly(meth)acrylic acid can also be useful. Further, the organic carboxylic acids may comprise acid salts in whole or as a part of the organic carboxylic acids.

These organic carboxylic acids may be used alone or in combination. Particularly preferred species of such organic carboxylic acids are citric acid, succinic acid, oxalic acid, tartaric acid and ethylenediaminetetracetic acid, salts thereof, maleic anhydride and succinic anhydride. The concentration of such organic carboxylic acid in a ternary dental composition consisting of organic carboxylic acid, metal chloride and water may range from 5 to 50 percent by weight and is preferably 5 to 30 percent by weight. In the case of citric acid, the range of 5 to 30 percent by weight is preferable. Outside of the above range, the etching effect will not be sufficient.

The metal chloride which can be incorporated in the ternary composition of this invention is potassium chloride or calcium chloride or a mixture thereof and the concentration of such metal chloride in the total composition may range from 5 to 50 percent by weight. Particularly beneficial is calcium chloride in the concentration range of 5 to 30 percent by weight.

Kojima et al (Journal of the Japanese Society for Dental Materials and Devices, 1, 131, 1982) reported the results they obtained by treating the tooth surface with an aqueous solution containing 10 weight percent of citric acid and 3 weight percent of a metal chloride. According to them, when zinc chloride was used as the metal chloride, the bond strength with respect to the dentin was not more than 44 Kg/cm^2, which is insufficient for a bonding agent.

Furthermore, ferric chloride provided a high bond strength with respect to the dentin but because the tooth surface was discolored brown on adsorption of iron ion, this metal salt was undesirable from aesthetic points of view. However, it is surprising that the dental composition of this invention, despite the fact that it contains a metal chloride in high concentration, does not cause discoloration of the dentin but assures a marked improvement in the adhesion of the filling material without detracting from the aesthetic quality of the tooth. However, if the concentration of the metal chloride exceeds 50 percent by weight, there may not be obtained a satisfactory etching effect.

In the dental composition of this invention, there may be incorporated, as desired, a thixotropic agent or rheology modifier so that the composition is fluid during application to the tooth surface, and so that it will rapidly lose fluidity after application (i.e. it is thixotropic), thus enabling topical application. The composition may be colored with an edible coloring agent for assisting in the identification of the application site. Examples of said thixotropic agent include high molecular weight thickeners such as polyvinylpyrrolidone, carboxymethylcellulose, highly dispersible silica such as fumed silica and the like. Examples of said edible coloring agent include various food colors which are commonly used in food and pharmaceutical industries.

The following examples are further illustrative of the dental composition of this invention.

Examples 1 to 14

Dental compositions were prepared in accordance with the formulations given in Table 1 using various organic carboxylic acids and metal chlorides. Each of these test compositions was prepared by charging a 100 ml beaker with the specified quantities of organic carboxylic acid and water and then with the specified quantity of metal chloride and stirring the contents thoroughly until a clear fluid was obtained. In like manner, control compositions were prepared in accordance with the formulations also given in Table 1. After the tooth was treated with each treating agent, a dental composite resin was applied to the tooth and the bond strength between the composite resin and the tooth was measured by the following procedure for evaluating the effect of the test compositions.

Bond Strength Test

The labial surface of a fresh bovine foretooth which has been preserved frozen immediately after extraction was buffed with silicon carbide paper to prepare a smooth enamel or dentin surface. Then, a spacer provided with an aperture having a specified area was placed on the polished surface. The test compositions preadjusted to the specified concentration was applied to the above enamel or dentin surface in the aperture and allowed to stand for 40 seconds. The tooth was rinsed and dried in an air current. The treated enamel or dentin surface was then coated with a bonding agent containing phosphate monomer (Cleafil® Photo Bond, Kuraray Co., Ltd.) and allowed to stand for 30 seconds. The volatile substance was evaporated off in an air current, and using a light irradiator (Quick Light, J. Morita Corporation), the bonding agent was photopolymerized for 20 seconds.

A dental composite resin (Cleafil® Photo Posterior, Kuraray Co., Ltd.) was placed on the above surface. Then, the resin was cured by exposure to said irradiator for 60 seconds. The spacer was removed and a stainless steel bar was rigidly secured to the cured composite resin with a dental cement containing phosphate monomer (Panavia®, Kuraray Co., Ltd.). The tooth was allowed to stand in water at 37°C for 24

hours, after which the tensile bond strength was measured using a universal tensile tester at a pulling speed of 2 mm/minute. It was thus assured that there would not be a failure between the cured composite resin and the stainless steel bar.

Effect of Treatment

The dental composition of this invention helped produce an improved bond between the dental composite resin and the tooth. In contrast, the reference control compositions provided for a sufficient bond strength with respect to the enamel but only an adequate bond to the dentin. Furthermore, an electron-microscopic comparison of Example 5 with Control Example 2 showed that Example 5 caused less denaturation damage to collagen fiber of bovine tooth pulp.

Table 1

	Acid		Metal chloride		Bond strength (Kg/cm^2)	
	Kind	Weight %	Kind	Weight %	Enamel	Dentin
Example 1	Citric acid	5	$CaCl_2$	5	104	102
Example 2	Citric acid	5	$CaCl_2$	50	176	80
Example 3	Citric acid	10	$CaCl_2$	5	186	103
Example 4	Citric acid	10	$CaCl_2$	10	160	97
Example 5	Citric acid	10	$CaCl_2$	20	199	110
Example 6	Citric acid	10	$CaCl_2$	40	188	81
Example 7	Citric acid	20	$CaCl_2$	20	193	120
Example 8	Citric acid	20	$CaCl_2$	30	173	127
Example 9	Citric acid	50	$CaCl_2$	5	186	102
Example 10	Citric acid	10	KCl	20	185	92
Example 11	Succinic acid	5	$CaCl_2$	10	106	90
Example 12	EDTA•2Na	15	$CaCl_2$	20	129	99
Example 13	Tartaric acid	10	$CaCl_2$	20	157	83
Example 14	Oxalic acid	10	KCl	20	128	87
Example 15	Maleic anhydride	10	$CaCl_2$	20	135	96
Example 16	Succinic anhydride	10	$CaCl_2$	20	124	85
Control Example 1	Phosphoric acid	40	-	-	204	71
Control Example 2	Phosphoric acid	50	$FeCl_3$	20	180	69
Control Example 3	Citric acid	10	-	-	144	70
Control Example 4	Citric acid	10	$FeCl_3$	3	140	74
Control Example 5	EDTA•2Na	15	-	-	98	79

It is apparent from the above results that the present invention provides a dental composition with which both the enamel and the dentin can be simultaneously treated.

Claims

1. A dental composition for the treatment of the enamel and/or dentin of a tooth, comprising an organic carboxylic acid or an anhydride thereof, a metal chloride and water, the concentration of said organic carboxylic acid or anhydride thereof being 5 to 50 weight percent based on the total weight of said composition, said metal chloride being potassium chloride or calcium chloride or a mixture thereof and the concentration of said metal chloride being 5 to 50 weight percent based on the total weight of said composition.

2. The dental composition of claim 1 wherein there is used an organic carboxylic acid which is citric acid, succinic acid, oxalic acid, tartaric acid or ethylenediaminetetracetic acid or a salt thereof.

3. The dental composition of claim 1 wherein there is used an organic carboxylic acid anhydride which is

maleic anhydride or succinic anhydride.

4. The dental compositon of claim 1 wherein there are used citric acid and calcium chloride and each is present in a concentration of 5 to 30 weight percent based on the total weight of the composition.

5. Use of the dental composition of any preceding claim for treating the enamel and/or dentin of a tooth, to improve adhesion of a subsequently applied filling material.